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Review of the implementation of Agenda 21 and the Johannesburg Plan of Implementation: waste management

Report of the Secretary-General

Summary

Waste management has evolved from a focus principally on collection and disposal/incineration to a more integrated approach that emphasizes waste minimization, material recycling and energy generation. In a number of countries, waste management is increasingly following an integrated, life-cycle approach. In developing countries, the rapid growth of waste volumes often taxes management capacities and overwhelms infrastructure. Hazardous waste poses particularly complex challenges, especially where it is intermixed with other waste streams.

Priority objectives for waste management include promoting waste prevention and minimization, effective and efficient management of remaining solid and hazardous waste, and focusing on reuse and recycling and on recovery of useful materials and energy. Waste is potentially a valuable resource.

Local authorities, often at the forefront of solid waste management, need institutional capacity-building and the delegation of responsibilities and of financial resources from Governments. Education and public awareness campaigns are important to promoting waste minimization and safe, environmentally sound disposal. Public-private partnerships can also play a role in financing and developing waste infrastructure and management systems.

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I. Introduction

1. The present report reviews progress in the implementation of Agenda 21,[1] the Programme for the Further Implementation of Agenda 21[2] and the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation"),[3] in the thematic area of waste. It takes into account decisions of the Commission on Sustainable Development at its sixth, twelfth, thirteenth and seventeenth sessions. The report was jointly prepared by the Department of Economic and Social Affairs of the United Nations Secretariat and the United Nations Environment Programme (UNEP). It draws on inputs provided by Governments, major groups and the United Nations system, in particular the Basel Convention on the Control of the Trans-boundary Movements of Hazardous Waste and Their Disposal, the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO), and the Organization for Economic Cooperation and Development (OECD).

II. Review of implementation

2. Effective management of solid waste, hazardous waste and sewage is essential to sustainable development, as mentioned in Agenda 21: "environmentally sound management of wastes was among the environmental issues of major concern in maintaining the quality of the Earth's environment and especially in achieving environmentally sound and sustainable development in all countries" (para. 21.1).

3. Solid waste includes all domestic refuse and non-hazardous waste, such as commercial and institutional waste, street sweepings and construction debris and, in some countries, human waste. Often hazardous waste is intermixed with other waste, which poses particular management challenges. As indicated in Agenda 21, action called for in chapter 21 ("Environmentally sound management of solid wastes and sewage-related issues") is closely related to issues addressed in other chapters, notably those on freshwater, sustainable human settlement development, and protection and promotion of human health.

4. The classification into hazardous and non-hazardous waste is based on the system for the classification and labelling of dangerous substances and preparations, which ensures the application of similar principles over their whole life cycle. Hazardous waste is waste that poses substantial or potential threats to public health or the environment and generally exhibits one or more of these characteristics: carcinogenic, ignitable (i.e., flammable), oxidant, corrosive, toxic, radioactive and explosive.

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[1] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992*, vol. I, *Resolutions adopted by the conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[2] General Assembly resolution S-19/2, annex.

[3] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 1, annex.

A. Assessment of current situation of waste management

1. Trends in production and consumption patterns and their impact on waste generation

(a) Progress towards sustainable production and consumption patterns

5. Population growth and economic development are the principal drivers of resource consumption as well as waste generation, and even if in principle they need not be perfectly correlated, in practice only a handful of countries have begun to achieve meaningful "decoupling" between income, consumption, material throughput, and waste production. Where it has happened, decoupling has been made possible by improvements in resource efficiency, structural change (including export of resource intensive industries) and increased rates of material recycling.

6. Although decoupling has yet to bring about a reversal in the seemingly inexorable rise of material throughput and waste volumes, there is evidence of a link between incomes and the willingness of societies to spend on environmental improvements, for example, through improved waste management systems. It is reflected in the emergence in many countries of an environmentally conscious consumer public, as well as the increased interest by businesses to promote environmentally sound consumer products.

(b) Impact on waste generation

7. Global data on waste generation are notoriously variable in quality. This is because of the lack of reporting by many countries, inconsistencies in reporting methods, and differences in definitions and surveying methods employed by countries.[4] The information presented below should therefore be used with caution.

8. The data reported here refer to the "collection phase", that is, the time when waste enters the economic stream. While relatively reliable data are available on municipal waste (though only for urban populations in emerging and developing countries), data on industrial wastes (both hazardous and non-hazardous) tend to be less comprehensive and consistent, even in developed countries.

9. The "Global Waste Management Market Assessment 2007"[5] estimates the global volume of municipal solid waste in 2006 to be 2 billion tons, projected to increase by approximately 8 per cent per year until 2011. There is a wide range between regions, both in per capita and aggregate terms. Table 1 provides an indication of the divergence between regions in terms of municipal solid waste generated in 2004.

[4] Elisabeth Lacoste and Philippe Chalmin, *From Waste to Resource: An Abstract of the 2006 World Waste Survey* (Paris, Economica Editions, 2006).

[5] A Key Note Market Report (United Kingdom, Key Note Publications, 2007).

Table 1
The collection of municipal waste worldwide: an attempted estimate for 2004 (in millions of metric tons)

OECD countries	620[a]
Commonwealth of Independent States (Baltic States excluded)	65[b]
Asia (except OECD)	300[c]
Central America	30[d]
South America	86[e]
North Africa and Middle East	50[f]
Sub-Saharan Africa	53[g]
Total	**1 204**

Source: E. Lacoste and P. Chalmin, *2006 World Waste Survey: From Waste to Resource* (Paris, Economica Editions, 2006).

Note: Extrapolations are calculated based on ratios concerning the GDP/inhabitant, the consumption of paper and paper-based products/inhabitant, the rate of urbanization and the total population. For emerging and developing countries, only the amount of urban waste was estimated.

[a] Statistics gathered.
[b] Extrapolation from data from 10 new European Union member countries.
[c] Statistics gathered and extrapolated for Viet Nam, Indonesia and Bangladesh.
[d] Extrapolation from Mexican data.
[e] Extrapolation from Brazilian and Argentinean data.
[f] Extrapolation from Egyptian data.
[g] Extrapolation from Kenyan data.

10. Finally, as mentioned, waste generation is strongly correlated with gross domestic product, and while there are exceptions the overall relationship is almost linear, showing little evidence of decoupling at higher income levels.

11. Although developed countries have recently succeeded in reducing the environmental impact of solid waste through such measures as sanitary landfills, high-temperature incineration, increased recycling, and use of waste for electricity generation, the aggregate waste volume is still either growing or has stabilized at very high levels.[6] In Europe, for example, municipal waste per capita has stabilized since 2000 but at an overall level for the European Union countries plus the countries of the European Free Trade Association of around 500 kilograms (kg) per capita.[7] The intensification of economic activities outweighs the effects of waste prevention and recycling initiatives.

12. Packing waste remains a major problem in the European Union member States. There has been a general increase over the past decade in per capita quantities of packaging being put on the market in both old and in the new member States. This is in spite of the fact that the European Union target of recycling 25 per cent of packaging waste in 2001 was exceeded, as was the 2006 target of 55 per cent.[8]

[6] United Nations Environment Programme, "Integrated Waste and Resource Management," 2007.
[7] See Department of Economic and Social Affairs Trends report 2010-11: chemicals, waste, transport and mining, New York.
[8] European Environment Agency, "Generation and recycling of packaging waste", assessment published in January 2008.

13. There has been a rapid increase in the overall waste volumes generated in developing countries over the past few decades and, in rapidly industrializing countries, rapid growth in industrial and hazardous waste as well. Rising incomes have enabled waste management infrastructure to expand in some cases, whereas in others growth in waste volumes has outstripped the expansion of management capacity.

14. For Latin America and the Caribbean, several World Bank studies project that municipal solid waste will increase from 131 million tons in 2005 to roughly 179 million in 2030.[9]

15. In Africa, while per capita waste generation remains very low in comparison with the world and OECD averages, the total volume is growing because of the high rate of population growth and urbanization. The total annual waste volume is estimated at around 200 million tons, of which anywhere from 30 to 50 per cent is not disposed properly.

16. Asia is also similar in that urbanization and economic growth are the main reasons for high levels of waste generation. In general, the per capita generation of solid waste is similar to the rates in many African cities.

17. As mentioned, data on industrial waste are highly unreliable, especially for hazardous waste (mainly because of conflicting definitions). Consistent data are available for the European Union, the United States of America, Canada, Japan, the Republic of Korea and Australia, but not for the Russian Federation or China. For China, for example, OECD estimates industrial waste to be 315 million tons in 2002, while a Chinese official study gives a figure of about 1 billion tons.

18. E-waste (also referred to as waste electrical and electronic equipment (WEEE)) is an emerging waste stream classified as hazardous (because of the presence of heavy metals and toxic chemicals). Estimates range from 7 to 13 kg per capita per year, which is equivalent to between 2.5 and 5 per cent of total global municipal waste. There are over a billion personal computers in the world; those in developed countries have an average life of just two years. In Europe e-waste is increasing by 3 to 5 per cent per year — almost three times faster than the total waste flow. Large quantities of e-waste find their way to developing countries.

19. Construction and demolition is, in respect of weight, another large waste stream in urban areas. In developed countries construction waste could be 10 to 15 per cent of total waste.

20. Mining waste takes up a great deal of space, blights the landscape and often affects local habitats.[10] By its very nature it can constitute a serious safety hazard. The European Environment Agency estimates that its member countries generate 400 million tons of mining waste every year, accounting for 29 per cent of total waste generated. Global estimates of material removed in the mining of iron, copper and gold alone range up to 33 billion tons per year, which dwarfs the 2 billion tons of municipal solid waste in comparison.

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[9] Public-Private Infrastructure Advisory Facility, "Managing Municipal Solid Waste in Latin America and the Caribbean", *Gridlines*, Note No. 29 (October 2007).

[10] For more detailed analysis of mining waste issues, see E/CN.17/2010/7.

(c) Economic, environmental, health and social impacts of current practices of waste management

21. Waste generation is connected with potential environmental, health and social problems. However, managing waste is costly. OECD countries spend about $120 billion a year disposing of their municipal waste alone and another $150 billion on industrial waste.

22. Costs occur along the entire waste supply chain, from collection through landfill disposal, incineration or recycling. Waste collection costs need to be covered to make the service financially sustainable. This may be done from tax revenue, for example, through a surcharge on property taxes. Collection fees are a widely used instrument, which may in some cases be added to water or electric utility bills.

23. Developing countries face challenges to properly manage waste. Most efforts are being made to reduce final volumes and generate sufficient funds for waste management. It is common for municipalities to spend 20 to 50 per cent of their recurring budget on solid waste management — even though only 40 to 60 per cent of urban waste is collected and less than 50 per cent of urban population is served. In middle income countries, collection costs 50 to 80 per cent of the solid waste management budget. In high income countries, with larger budgets and upfront community participation in recycling and recovery, collection accounts for less than 10 per cent of the budget, which allows large funds to be allocated to waste treatment facilities.[11]

24. In low income countries, almost the entire budget (80-90 per cent) of municipal solid waste management is allocated to collection. In general, in the developing world, few cities have adequate solid waste collection and disposal systems, and the accumulating waste threatens health, damages the environment, and detracts from the quality of life.

25. In 2002, a World Health Organization (WHO) assessment in 22 developing countries showed that between 18 and 64 per cent of health-care facilities did not use proper waste disposal methods. Worldwide, 8 to 16 million cases of hepatitis B, 2.3 to 4.7 million hepatitis C, and 80,000 to 160,000 HIV infections occur yearly because of reused unsterilized syringes and needles. Additional health hazards occur from scavenging on waste disposal sites and from manual sorting of the waste at health-care facilities.

2. National and local procedures for assessing waste quantity

26. Waste definitions vary from country to country and the reporting mechanisms as well as the reliability of reported data also vary. In the absence of scientific data collection mechanisms, quite often data are reported on an "estimation" basis. Such data should be taken merely as indicative of trends. Relatively reliable data on waste is available mainly from OECD countries. In developing countries, waste quantity is generally assessed based on per capita waste generation factors, sometimes supported with basic studies. Generally, the assessment of hazardous waste, particularly industrial hazardous waste, is better owing to reporting requirements for

[11] United Nations Environment Programme, "Developing integrated solid waste management plan, Training manual", vol. 1, "Waste characterization and quantification, with projections for future", 2009.

the Basel Convention. The data on waste streams such as waste agricultural biomass, construction and demolition waste is generally the weakest.

3. Current monitoring methodologies

27. For effective monitoring of waste generation, it is important to establish waste treatment and disposal quality criteria based on the assimilative capacity of the receiving environment, to undertake waste-related pollution impact monitoring and conduct regular surveillance.

28. In most developed countries, waste monitoring is conducted through waste characterization studies (to analyse waste streams), customers' surveys usually carried out over a five-year period, and market analyses of targeted materials conducted to assess current and future markets for recyclable materials.

29. Few developing countries have an effective regulatory framework or the infrastructure to monitor waste properly. Communities handling and processing waste are unaware of the dangers owing to the lack of a system to warn retailers and users about hazards.[12]

Box 1
Waste monitoring in Romania

Romania is an example of an emerging country with successful waste monitoring. Measures have been taken at all levels — legislative, organizational, institutional, and financial — and a network of specialized monitoring stations has been set up to follow up on environmental quality. Romania is committed to fulfilling the agreements of the international conventions on the environment.

In Romania, all waste monitoring initiatives are organized at the national level. A supervisory network for the monitoring of environmental quality and collection of data on pollutant emissions and transfers as well for storage and processing of such data is set up to make waste monitoring successful. The network has proven to be efficient and has identified 25 localities in the country as hot spots.

Source: World Bank, "Observations of solid waste landfills in developing countries", 2009.

30. Most regions in the world are suffering from poor waste monitoring mechanisms. Some countries lack resources and financial assistance while others need stricter regulations and enforcement to monitor trends in waste generation.[13]

31. African cities need financial assistance and the infrastructure to construct transfer stations for waste and hire more waste collectors.[14] Today, the region

[12] United Nations Environment Programme, "533 tools and methodologies for monitoring and controlling chemicals and waste", 2009.

[13] O. Kofie and A. Bradford, "Organic Waste Reuse for Urban Agriculture", International Development Research Centre.

[14] World Bank, "Observations of solid waste landfills in developing countries", 2009.

receives the lowest level of investment of World Bank funds in waste monitoring technology, such as specimen banking. Greater investment in such technology would help establish retrospective baseline data and provide a tool for assessment and management of long-term environmental trends.[14]

32. In Asian countries, such as China and India, national and regional authorities record and inspect incoming waste but rarely monitor the environmental effects of waste disposal. In some cases, this has led to relaxed application of environmental mitigation measures and greater tolerance of open fires on a landfill.

33. Central Asian countries, such as Uzbekistan and Kazakhstan, struggle to meet governmental waste monitoring demands. Some important waste streams are not properly monitored. Inventories of high potential hazardous waste are lacking in several countries, while data quality is often uncertain. Data collected are often incomplete and little work has been done to analyse or synthesize data for policy development and assessment.[14]

34. Latin America and Caribbean countries also have weak and outdated waste monitoring, and waste management plans are often inadequate. While the sheer volume of waste does not constitute the problem, the inability of Governments and waste-disposal firms to keep up with waste is the core issue.

B. National and local polices and strategies for waste management

1. National and local policies

35. Although the concept of waste prevention is broadly accepted, it is apparent that ever-growing waste amounts, waste diversity, and associated risks are heightening the need for Governments to pursue waste prevention measures more vigorously. The 3Rs (reduce, reuse, and recycle) concept has yet to be widely implemented, with the focus of many existing waste management policies and programmes continuing to be on collecting and disposing of waste once it has been generated.

36. Around the globe, countries have developed national policies and strategies. In developing countries, although many Governments have formulated waste management policies and strategies, implementation and enforcement are often weak apart from selected urban centres. In many developing countries, informal waste collection and recycling dominate owing to gaps in public funding and policy.

37. Some specific examples of national policies are described below. In many countries, there are trends towards decentralization of environmental responsibilities from national to subnational authorities, increasing public participation and public-private partnerships.

38. Canada has developed a Competitiveness and Environmental Sustainability Framework to realize economic and environmental integration. The framework will address, among other items, 3Rs issues. To oversee this policy framework, the Prime Minister has established a cabinet subcommittee for environment and sustainable development. Most implementation of the 3Rs has been at the subnational level in Canada.

39. In Germany, the 3Rs policy has stabilized waste volumes over the last 15 years, and has increased recycling rates through sound waste treatment. Now the

Government is aiming towards the development of a closed-loop circular economy with maximum waste reduction, recycling and reuse. Germany aims to end landfilling by 2020.[15]

40. In South Africa, the Government adopted a national waste management strategy in 1999 and introduced regulations restricting the use of plastic bags, banning the use of asbestos where possible, and eliminating mercury dumping. Civil society has also contributed to the effort, for example, through training services.[16]

41. In Brazil, the proposed National Solid Waste Policy Law incorporates the principles of the 3Rs. The Government is promoting separated garbage collection in municipalities. Successful private sector initiatives include aluminium can recycling, with a success rate above 95 per cent. Local garbage pickers perform an essential and increasing role, and have formed organizations with aid from NGOs.

42. In 2004, Mexico passed the General Law for the Prevention and Integral Management of Wastes promoting the 3Rs policies. Voluntary programmes are also carried out to promote clean industry policies in the tourism sector and the beer industry, among others. Some 30,000 firms in the private sector have also registered in a voluntary census on hazardous waste. Currently, 95 per cent of glass and 75 per cent of paper is being recycled. Methane gas emitted from landfills is also being used as a low-cost energy source.

43. The Republic of Korea has enacted legislation to promote the recycling of construction waste and the purchasing of eco-friendly products. A volume-based waste fee system was introduced in 1995. Proper sorting and collection of waste is administered by collection services for recyclable products at no cost, resulting in a 23 per cent reduction of per capita waste generation over the past 10 years.

44. In China, the Government is seeking to establish a circular economy, through a legislative framework and experimentation at the local level. The circular economy policy is incorporated in China's eleventh five-year national development plan.[15]

45. Japan has adopted laws that constitute the country's system of legal and voluntary initiatives as part of the system-wide policy development effort. The most important of these was the Fundamental Law for Establishing a Sound Material-Cycle Society, which established the basic principles for the creation of a recycle-oriented society.[17] Japan aims to realize a zero-waste society in Japan based on the quantitative targets and further 3R actions, and to disseminate its experience to the international community.

46. In the Philippines, the Ecological Solid Waste Management Act, and the Toxic Substances and Hazardous and Nuclear Waste Control Act have institutionalized waste recycling and composting, and prescribed the management, treatment and disposal of toxic and hazardous waste. There are efforts to promote segregation at source through capacity-building in municipalities and financing 3Rs education programmes, and to move towards sanitary landfills.

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[15] Information submitted to the Ministerial Conference on the 3R Initiative, held in Tokyo, from 28-30 April 2005.

[16] http://www.iwmsa.co.za/index.php?option=com_frontpage&Itemid=1.

[17] Asian Development Bank, *Towards Resource-Efficient Economics in Asia and the Pacific: Reduce, Reuse, Recycle*, 2008.

47. The Government has developed a national integrated waste management plan. It has also taken measures to prevent the export of waste to Thailand. Many 3Rs projects are being implemented, including Government green procurement, a waste exchange programme with over 400 industries currently registered, and tax incentives to encourage the recycling of lead-acid batteries.

48. In 2006, the Government of India enunciated a waste reduction and minimization strategy through its National Environment Policy, which envisaged strengthening the capacities of local bodies for segregation, recycling and reuse of municipal solid waste. The policy provides legal recognition for and strengthens the informal systems of collection and recycling of various materials. Policies and regulations have also been formulated for the management of municipal solid waste, medical waste and hazardous waste.

49. In Australia, provisions encouraging waste recycling and reuse are contained in laws governing hazardous wastes and renewable energy as well as environment protection. For the problem of e-waste, the Government has implemented stricter regulations on take-back schemes, superseding industry-based voluntary recycling schemes.[18]

2. Regulations and economic incentives

50. In general, no individual waste prevention tool is likely to promote an absolute reduction in waste without the aid of complementary tools and approaches. Depending on the context, public awareness campaigns, regulatory instruments, and economic instruments need to be used in combination. Economic instruments, such as resource taxes and household user fees combined with landfill taxes, have been particularly useful for inducing overarching waste prevention behaviour. Many developed countries such as Denmark impose laws requiring all waste producers to pay a tax on the incineration and landfilling of waste.

51. Other countries and states have incorporated similar initiatives. For example in Italy, a landfill tax is promoting 3R waste policies, making economically attractive a reduction in biodegradable waste sent to landfills. Eco-prizes are awarded for environmentally friendly packaging and for using recycled raw materials. Over 30 per cent of products used by State-owned firms and governmental agencies must be made from recycled materials.[15]

52. In the United States, Washington State Law requires that all businesses that generate any amount of hazardous waste pay a "hazardous waste generation fee". Funds collected are used to support waste reduction activities such as educational workshops.[19]

3. Private sector initiatives and experiences

53. While many industrialized countries have successfully mobilized the private sector in the environmentally sound management, reuse and recycling of waste,

[18] Spire Research and Consulting Ltd, "Recycling for the Next Generation: How impending recycling legalisation will change the way businesses work", 2006.

[19] Washington State Department of Ecology.

some examples of such mobilization have also emerged in developing countries. By and large, the private sector's role is much less prominent in these countries.[20]

54. In the Philippines, for instance, local government units, NGOs and private corporations have initiated recycling activities.

55. Eastern European countries are facing difficulties in financing the centrally controlled model of solid waste management service delivery and are turning increasingly to the private sector for services, including collection and disposal. In some cities, residents are paying fees directly to private collectors.[21]

56. In Latin America, private collection firms have the exclusive right to service specific areas in many cities and contracts are awarded by competitive bidding. Local authorities still need to establish operational and environmental regulations and standards to guide private contractors and oversee their activities.

57. In South Africa, the waste management sector is dominated by the private sector with selective operations in the recycling of saleable products.[22]

C. International and regional initiatives for waste management

58. Some regional mechanisms and international instruments already exist mainly in capacity-building. Below are few examples of international and regional initiatives.

1. Marrakech Process

59. The Marrakech Process is a global process led by the Department of Economic and Social Affairs (and the United Nations Environment Programme (UNEP) with active participation of national Governments, development agencies, and civil society. Its goals are: to support the elaboration of a 10-year framework of programmes on sustainable consumption and production in order to assist countries in their efforts to green their economies, help corporations develop greener business models, and encourage consumers to adopt more sustainable lifestyles. Waste management has been identified as a regional priority in a number of regional meetings held under the auspices of the Marrakech Process, and a programme of support to integrated waste management at national and local levels will most likely be included in a 10-year framework of programmes (see E/CN.17/2010/8).

2. Basel Convention

60. The implementation of the Basel Convention provides evidence that transboundary movements of hazardous waste cannot be meaningfully addressed in isolation from the entire set of waste issues. The hazardous waste issues dealt with under the Convention overlap with and are in many ways inseparable from the issues surrounding municipal and other waste.

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[20] *Solid Waste Management and Recycling: Actors, Partnerships and Policies in Hyderabad, India, and Nairobi, Kenya*, I. Baud and others (eds), Dordrecht, GeoLibraries Series No. 76, Kluwer Academic Publishers, 2004.

[21] United Nations Environment Programme, "International source book on environmentally sound technologies for municipal solid waste management", 2009.

[22] Toma V. Golush, (ed.) "Waste Management Research Trends" (New York, Nova Science Publishers, 2008).

61. One important emerging issue under the Basel Convention is end-of-life electronics products. By one estimate, 230,000 computers are scrapped in the United States each day, and 90 per cent of those are not recycled domestically.[23] Large quantities of e-waste are being exported to developing countries for reuse, repair, refurbishment, recycling and recovery of non-ferrous and precious metals at facilities that do not always operate under sound environmental conditions. Recognizing the importance and global dimension of the e-waste problem, the Conference of the Parties to the Basel Convention, held in December 2006, adopted the Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste. Subsequently, at its ninth meeting, held in Bali in June 2009, a global workplan was adopted by the Conference of the Parties. The e-waste workplan includes, for example, a global partnership on computing equipment and the development of technical guidelines on the environmentally sound management of e-waste.

3. Regional initiatives

62. The OECD Environmental Strategy, adopted by the Environment Ministers in May 2001, outlined the need for such integrated solutions as sustainable materials management, and led to recommendations adopted by the OECD Council in April 2004.

63. On 21 December 2005, the European Commission proposed a new long-term strategy that aims to make Europe a recycling society, which seeks to avoid waste and uses waste as a resource, in part by introducing a life-cycle approach to waste policy.

64. The Government of Japan has put forward the 3Rs (reduce, reuse, and recycling) Initiative for the endorsement of the leaders of the Group of Eight countries at the 2008 summit in Hokkaido, Japan. It is now working to disseminate it at the regional level. The Initiative has a strong focus on waste prevention and minimization.

D. Environmentally sound waste reuse and recycling

1. Assessment of current levels of waste reuse and recycling

65. Recycling and reuse of waste follows several routes. In developing countries, often materials are segregated from waste and recycled for secondary uses. This includes paper, bottles, textiles, and the like. Discarded products (especially WEEE) are refurbished and sold off as second-hand products. Some waste (such as construction and demolition debris, organic waste converted into compost), with little or no processing, are reused for other purposes. Quite often waste is incinerated to meet thermal energy needs, for example, for cooking in rural areas.

66. The extent of recovery and recycling depends on such factors as the market for recycled materials, price of recycled material vis-à-vis virgin materials, local economic conditions, and so on. The estimated size of the main world secondary material market is given in table 2.

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[23] Alan Hershkowitz, Natural Resources Defence Council presentation at a seminar on "Waste management", held at United Nations Headquarters, 12 January 2010.

Table 2
Estimated size of main world secondary material markets, 2004
(Millions of tons)

Recovered fibres (paper): 170
Recovered ferrous metals (scrap metal): 405
Recovered on-ferrous metals: 24
Recovered plastics: 5
Total: Approximately 600

Source: E. Lacoste, P. Chalmin, *2006 World Waste Survey: From Waste to Resource* (Paris, Economica Editions, 2006).

67. The estimated amount of materials collected from municipal waste in Europe and the United States is given in table 3.

Table 3
Recovery of materials from municipal waste in Europe and the United States
(Thousands of tons)

	Germany	*France*	*United Kingdom*	*Italy*	*Spain*	*Total Europe*	*United States*
Paper and cardboard[a]	8 500	5 200	3 700	2 000	3 500	32 700	40 000
Plastics	3 850	350	450	350	310	6 500	1 930
Glass	3 300	2 000	1 500	1 000	510	10 000	2 350
Non-ferrous metals	1 204	1 750	75	278	121	3 975	1 750
Total	**16 854**	**9 300**	**5 725**	**3 628**	**4 441**	**53 175**	**46 030**
Batteries	11.5	9.6	—	—	—	28	—
End-of-life vehicles — ferrous metals						11 000	17 000

Source: E. Lacoste, P. Chalmin, *2006 World Waste Survey: From Waste to Resource* (Paris, Economica Editions, 2006).

[a] Recovered from municipal and industrial waste.

68. Recycling in developing countries is mainly through the unorganized sector: an informal network of rag-pickers (both from primary disposal points as well as intermediate/final disposal areas), door-to-door collectors, primary and secondary dealers and, finally, recycling industries. There are no official estimates of the extent of such recycling. Informal recycling is a source of livelihood for many mostly poor people in developing countries. It is estimated that the recycling for high-value items — for example, metal, clean paper and plastic, and so on — is relatively high as compared to that of organic constituents (except for isolated examples such as Bangladesh where organic waste recovery is widespread).

69. The European region is making substantial progress in incorporating sounder waste methods. For example, recycling has greatly reduced waste generation in the United Kingdom. Increases in recycling since 2000 have more than offset increases in waste generation, reducing the volume of municipal waste for disposal by 15 per cent.

A landfill tax has also provided an incentive for both waste reduction and recycling. Furthermore, the European Union, where consumer interest and governmental involvement are high, is implementing new recycling-related legislation.[22]

70. Household recycling has expanded dramatically in many OECD countries. In the United States, some 9,000 municipalities have introduced public collection of separated household waste for recycling since the 1970s, with some achieving municipal waste recovery rates of 50 per cent.[21]

71. In some villages in Fiji, an Environment Committee has been formed and has implemented the policy on reuse, recycling and composting of organic matter as well as collection and disposal of residual solid waste[21].

72. Latin America has wide variations in the practice of recycling across countries, owing largely to the systems of rewards and punishments that are in place. According to the Brazilian Aluminum Association, about 80 per cent of the 9.5 billion aluminium cans sold in 2000 were recycled. This would put Brazil right among the ranks of world's recycling leaders such as Japan. Whereas Japan's system is based upon responsible citizenship, Brazil uses economic incentives. In the major metropolitan areas, there are many recycling centres that buy back recyclable materials for cash or discount foods.[24]

73. While Africa has the least resources for implementing more advanced waste methods, it is making a strong push towards achieving environmental standards. For example, the United Republic of Tanzania has been aggressive in the fight against heavy use of plastic bags. In 2006, Vice-President Ali Mohamed Shein declared a total ban on plastic bags. Kenya and Uganda are implementing less severe restrictions, imposing levies on thicker plastic bags.[25]

74. Communities in many developing countries are starting to carry out significant waste reduction practices. In designing strategies for further waste reduction, however, the first principle should be to build on what exists and appears to be working. This entails an understanding and assessment of local practices in waste reduction, waste recovery, and recycling.

2. Environmentally sound waste treatment and disposal

(a) Assessment of technologies for waste treatment and disposal

75. There is a consensus among environmentalists that zero waste can only be achieved with the complete adoption of cleaner technology. Reducing to zero-waste levels would entail the continuous application of an integrated preventative environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment.[26] A number of cities around the world have adopted zero waste as a goal, including Los Angeles in the United States and several cities in Italy.[27] One of the goals of the Los Angeles zero-waste plan is to divert 70 per cent of trash from landfills by 2015.

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[24] Zona Latina, "Recycling in Latin America", 2002.

[25] "Trends from around the world", reusablebags.com, 2009.

[26] United Nations Environment Programme, "Introduction to Cleaner Production (CP) concepts and practice".

[27] Presentation by Paul Connett, St. Lawrence University, a seminar on "Waste management", held at United Nations Headquarters, on 12 January 2010.

Box 2
World Bank waste collection and disposal statistics

The World Bank evaluation on collection and disposal of waste: urban waste collection and disposal (percentage of waste tonnes handled):

- Developed countries — High income

  Collection — 100 per cent

  Safe disposal — 100 per cent

- Developing countries — Middle income

  Collection — 60 per cent

  Safe disposal — 30 per cent

- Developing countries — Low income

  Collection — 40 per cent

  Safe disposal — 5 per cent

Source: Estimates of S. Cointreau, 2007.

(i) Landfills

76. Europe still relies mostly on landfills technology as the primary disposal technology for solid waste generated in the region, with Greece leading the region followed by Ireland and the United Kingdom. Denmark leads the group relying primarily on incineration as a waste treatment technology. Composting and recycling are very much lagging behind incineration and landfills, while plasma and syngas are still under consideration.[28]

77. In some countries such as the United Kingdom where the geology lends itself to landfills, it is more cost effective to landfill waste than to incinerate. In other parts of the world such as in Austria, Belgium, Germany, Japan, the Netherlands, and the Scandinavian countries, more waste is recycled or incinerated.

78. In Asia, incineration and landfills are still the most widely used solid waste treatment and disposal technologies in most cities.[29]

79. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as windblown litter, attraction of vermin, and generation of liquid leachate.

80. Many landfills in developing countries are dumps on open plots, wetlands and lands with water near the surface. At the same time, many developing countries have sanitary landfills and others are in the process of upgrading landfills to sanitary

[28] "OECD, Eurostat, Landfilling and Incineration still leading Europe, 2002 and 2001", published in UNEP/GRID Arendal, *Vital Waste Graphics*, 2004.

[29] Environmental Protection Department, Hong Kong, China, "Waste Disposal", 2006.

ones, including South Africa, Uganda, Ghana and Egypt. A number of developing countries have had tipping fees for landfills in place for many years.

81. One critical issue is that hazardous waste is sometimes disposed of along with non-hazardous solid waste, which is collected and deposited in municipal landfills and open dumps.

(ii) Incineration

82. Incinerators are costly and used mostly in developed countries (see table 4). Additionally, the high organic and water content of the waste stream makes incinerators energy consumers rather than energy producers. Incineration in Nigeria and the United Republic of Tanzania has proven unsustainable. A few cities, however, such as Yaoundé and Bamenda in Cameroon, use incineration on a small scale for hazardous waste such as hospital waste.[30]

Table 4
Incineration as share of municipal waste

Country	*Percentage*
Japan	74
Denmark	58
Switzerland	47
Netherlands	42
United Kingdom	9

Source: The Open University, "Working with our environment: technology for a sustainable future", 2005; Eurostat.

83. In 1990, the United States Environmental Protection Agency estimated that, by the year 2000, the United States would be incinerating 26 per cent of its solid waste, but by 1992, the Agency had lowered that estimate to 21 per cent. Today, even that reduced estimate seems overly optimistic.[31]

84. Views differ markedly on the desirability of incineration versus other waste treatment options. Historically, toxic emissions (dioxins and furans) were a major health concern but improved emission control designs have lessened this concern. Fine particle and heavy metal emissions remain a cause of concern, as does the safe disposal of toxic fly ash.

(iii) Composting

85. Controlled composting, which is converting waste into fertilizer for the soil, is the safest way to produce high quality products for soil amendment.[32] While expensive, composting can have many environmental advantages such as enriching soil, cleaning up contaminated soil, avoiding pollution, and offering economic benefits by lessening the demand for water, fertilizers, and pesticides.[32]

[30] Eric Achankeng, "Globalization, urbanization and municipal solid waste in Africa", University of Adelaide, Australia, 2003.

[31] United States Environmental Protection Agency, "Incineration technology", 2001.

[32] World Bank, project guidance material, www.worldbank.org/solidwaste, 2007.

86. Owing to its high costs, compost is a technique used on a large scale mostly by developed countries, even though most developing countries have a high percentage (50-80 per cent) of organic matter with high moisture content in their waste stream. In the European region, a number of composting facilities exist and different composting systems are being applied. Overall, there is a tendency to establish larger plants. In principal, European composting facilities run successfully, but the potential for improvement still exists.[32]

87. In Africa, composting at industrial scale was tried in Dakar and Abidjan but soon failed owing to the lack of demand for the final product.[30]

88. International non-governmental organizations (NGOs) have sponsored small scale composting in Benin, Cameroon, Egypt, Kenya, Nigeria, South Africa, and Zambia, but the practice has not had significant impact on cities' reduction of municipal solid waste. Poor quality of the manure resulting from inadequate segregation of waste appears to have contributed to the low demand.

89. India, Pakistan and Sri Lanka have adopted decentralized composting schemes. In India, many small-scale composting initiatives, often receiving international assistance, were initiated by NGOs or community groups, particularly in the 1990s.[33] In Sri Lanka, several composting activities were initiated by the Government, people's organizations, academic institutions, and private companies, but met little success, either because of the marginal quality of the product or the lack of viable markets.[33]

90. Among successful, community-based examples can be cited the decentralized composting scheme in Mirpur community in Dhaka. Today, the plant operates at full capacity, processing around three tons of raw waste per day.

91. The experience with composting in developing countries suggests the need in future for ensuring higher and more consistent quality of compost, including through better waste segregation, as well as effective marketing to ensure adequate demand.

(iv) Recovery of energy from waste

92. Recovery of energy from waste describes the process of creating energy in the form of electricity or heat from the incineration of a waste source. Most waste-to-energy processes produce electricity directly through combustion or produce a combustible fuel, such as methane, methanol, ethanol or synthetic fuels. Although incineration of municipal waste coupled with energy recovery can form part of an integrated waste management system, strict controls are required to prevent negative impacts on human health and environment.[33]

93. Waste-to-energy has thrived in Europe and Asia. Today, the European Union considers waste-to-energy as the preferred method of waste disposal.[34] European countries with the highest proportions of municipal waste thermally treated for energy generation are: Luxembourg, Sweden, Denmark, France, Belgium, the Netherlands and Germany. Waste-to-energy facilities in Europe can provide 20 million inhabitants with electricity and 32 million with heat.[34]

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[33] The Chartered Institution of Water and Environment Management, "Energy recovery from waste", 2009.

[34] Alternative Energy, "Waste as a renewable energy source", September 2008.

94. It would be, however, incorrect to assume that all countries in Europe are excelling in energy recovery from wastes. Only 10 per cent of municipal waste in the United Kingdom is currently managed through energy recovery. Energy from waste has the potential to replace up to one third of the coal used to generate electricity in the United Kingdom and easily satisfy the 2010 target of 10 per cent of electricity generated from renewable sources.[33]

(v) Gasification

95. The term describes a chemical process by which carbonaceous (hydrocarbon) materials (coal, petroleum coke, biomass, etc.) are converted to a synthesis gas (syngas) by means of partial oxidation with air, oxygen, and/or steam.[35] Syngas is most often produced from coal, but also from biomass or municipal waste.

96. In a 2004 survey, the Gasification Technologies Council identified 385 gasifiers in use at some 177 projects in 27 nations. Major projects are operating successfully.[35]

97. The world's largest concentration of gasifiers is in South Africa where synthetic fuels and chemicals have been produced from coal since 1955. The gasification projects at Sasol and Secunda use some 100 gasifiers to produce more than 40 per cent of South Africa's liquid fuels and a variety of chemical products.[35]

98. In Asia, gasification plants are operating in China, India and Japan. Five large integrated gasification combined cycle projects operate in Western Europe, with the greatest concentration in Italy. The three Italian projects produce more than 1,500 megawatts electrical of electricity from refinery residuals.

99. In North America, gasification is used to produce chemicals, fertilizers, and electricity at several sites across the United States. Major projects include a coal-to-chemicals facility in Kingsport, Tennessee, and a coal-to-methane (natural gas) project in North Dakota.

E. Radioactive waste

100. Developing countries often find it too difficult to afford nuclear power plants and other facilities that produce radioactive waste. With some notable exceptions, developed countries are the main producers of radioactive waste.

101. The global inventory of radioactive waste managed today amounts to circa 7 million cubic metres of low- and intermediate-level waste, 200,000 tons (heavy metal) of spent nuclear fuel, 800,000 cubic metres of high-level waste and 2 billion cubic metres of residues coming from the uranium production cycle. This waste is managed in a variety of storage and disposal facilities. Storage and disposal of low-level radioactive waste is a well-established practice worldwide. Storage of spent nuclear fuel and high-level waste is also a well-established practice. Disposal of spent nuclear fuel and high-level waste, while at a mature stage of conceptual development, remains to be implemented.

102. There are two types of radioactive waste. High-level radioactive waste results primarily from the fuel used by reactors to produce electricity while low-level

[35] Clean-energy, US, http://www.clean-energy.us/facts/gasification.htm, 2009.

radioactive waste results from reactor operations and from medical, academic, industrial, and other commercial uses. Globally, approximately 4 million cubic feet and 530,000 curies of low-level radioactive waste were disposed of in 2005. Although the relative amount of high-level radioactive waste is negligible with respect to the total volume of radioactive waste produced in nuclear power programmes, it contains 99 per cent of the radioactivity in this volume. Thus, high-level waste needs to be handled carefully.[36]

103. Disposal facilities for spent nuclear fuel or high-level waste from reprocessing have so far not yet been implemented. However, quantities of high-level radioactive waste arising are small and can be stored safely for extended periods of time. As of 2008, about 170,000 tons were in storage in OECD countries (which have 83 per cent of the worldwide installed nuclear capacity).

104. To manage radioactive waste, the international community follows the global nuclear safety regime, including:

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
- International safety standards
- National legal and regulatory framework
- IAEA regulatory review services.

105. Radioactive waste of all kinds needs to be managed responsibly to ensure public safety and protection of the environment, as well as security from malicious intervention, now and in the future. The most challenging task involves management of the long-lived waste that must be isolated from the human environment for thousands of years. The most common option for eventual disposal is emplacement in repositories deep underground in well-chosen geologic media.[36]

106. The available literature suggests that while geological disposal of spent nuclear fuel and high-level radioactive waste is technically feasible, the search for and selection of disposal sites has proven to be politically and socially challenging. Recent experience shows the benefit of open and transparent processes that allow sufficient time and include a concerted effort to assure that there is meaningful involvement of all stakeholders in the decision-making processes by following a flexible and adaptable strategy.

107. The European Commission has endorsed geological disposal as the favoured strategy for dealing with Europe's long-lived radioactive waste, and is close to implementing its first geological repositories for nuclear waste. The European Union generates about 35 per cent of its electricity from nuclear energy.[37]

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[36] Nuclear Energy Agency, "The disposal of high-level radioactive waste", *NEA Issue Brief*, No. 3 (January 1989).

[37] Neil A. Chapman, "Geological disposal of radioactive wastes — concept, status, and trends", *Journal of Iberian Geology*, vol. 32, No. 1 (2006).

III. International cooperation: the way forward

108. The rapid increase in volume and type of both solid and hazardous waste is a result of economic growth, technological advance, urbanization and industrialization. Ineffective and inefficient waste management results in adverse impacts on the health of surrounding communities; pollution of land, water and air resources; wastage of potentially valuable materials; and emissions of greenhouse gas. Effective and environmentally sound waste management requires immediate attention from national and local governments, particularly in developing countries. However, waste management systems are costly, and often beyond the reach of poor countries and poor communities. Some technological options are also unavailable for these countries. Finally, poor countries need investment in capacity development in order to manage these tasks effectively. The following elements are indicative of the way forward.

109. First, comprehensive national and local policies on waste management covering all types of waste and all aspects of waste management need to be formulated and rigorously enforced. Policy frameworks to support resource recovery from waste need to be strengthened as well. The economic, environmental and social benefits, as well as the local applicability, of an integrated solid waste management approach with a focus on the 3Rs have been demonstrated, but need to be more widely disseminated.

110. In this regard, the priority objectives are waste prevention and minimization, followed by the effective and efficient management of remaining solid and hazardous waste, focusing on reuse and recycling and on recovery of useful materials and energy. In the future, waste has to be valued as a resource.

111. One successful approach is based on life-cycle analysis, for example, through the application of extended producer responsibility and linking of the waste agenda with that of sustainable consumption and production.

112. Secondly, as mentioned, a significant obstacle to effective waste management is cost. There is a need for investment in the development of low-cost options suitable for poor communities, which could be upgraded as incomes rise. This will require long-term technical cooperation between developed and developing countries. Governments will need to tap the resources and expertise resulting from north-south and south-south cooperation and partnerships. Donor countries can assist developing countries by allocating higher portions of official development assistance (ODA) to waste management programmes, providing a higher proportion of financial assistance in the form of grants and improving donor coordination in implementation efforts.

113. Thirdly, in this regard, the importance of transferring and diffusing appropriate technologies and know-how for waste treatment, recycling and reuse and disposal cannot be overemphasized. This should be backed with proper technical training supported by international and bilateral development agencies. In this context, small-scale entrepreneurs can play a significant role in waste collection and treatment. Ways need to be found of integrating informal waste collection and recycling into formal, better regulated systems. Current international partnerships promoting cleaner production and life-cycle management therefore need to be strengthened.

114. Fourthly, intensive efforts are needed in capacity-building of the relevant stakeholders, including for developing and implementing integrated solid waste management at the local level, and providing policymakers in developing and transition countries with tools for financing waste management. Local authorities, often at the forefront of solid waste management, need institutional capacity-building and the delegation of responsibilities and of financial resources from Governments.

115. It is vital to engage communities and NGOs and other partners in the development of public awareness campaigns and education on waste prevention, waste treatment and health hazards from waste. It is a major challenge to reach the poorest segments of the population such as scavengers and rag-pickers.

116. Public-private partnerships can also play a role in financing and developing waste infrastructure and management systems.

117. Sixthly, such emerging waste streams as electronic waste, waste plastics, and used oils and chemicals require special attention aiming at a high rate of recovery worldwide. Therefore, an assessment of the quantities and characteristics of waste streams needs to be carried out so as to identify programmes and appropriate environmentally sound technologies to promote material and energy recovery. This will help to augment resources, while substantially reducing the final volumes and the toxicity of waste. For this to happen, a comprehensive programme for the transfer of know-how and technologies has to be developed.

118. Seventhly, there is broad consensus among experts that the quality of global data needs to be improved, not only with respect to the current amount of different types of waste generated, but also with respect to the expected future amounts, in order to develop projections that will allow adequate planning for resource recovery and substitution of virgin materials. Scientifically sound waste characterization and quantification for all waste streams and in all high-waste-generating areas need to be carried out. The International Panel for Sustainable Resource Management has started work on estimating the benefits of metal recycling now and in the future, as the basis for more efficient urban mining practices. However, similar work has to be carried out for a number of other materials and eventually for the global material flows.

119. An important first step in that direction is support for the improvement of regulatory frameworks and infrastructures, monitoring and data-collection capabilities for the effective monitoring of waste generation, treatment and disposal, and the establishment of criteria for waste treatment and disposal quality. This should be supported by effective national institutions with the necessary backstopping from the international community.

120. Under the Green Economy Initiative, research is being conducted on win-win options in waste recycling, namely those that lead to improved public health, poverty alleviation, creation of decent jobs, improvements in living standards, the reduction of greenhouse gas emissions and other pollutants, and the extended life of resources. The results would be available for consideration of decision makers, in particular in developing countries and countries with economies in transition.